

ON PORTIONS OF
A CRANIUM AND A JAW

IN THE SLAB CONTAINING THE FOSSIL REMAINS

OF THE

ARCHÆOPTERYX

BY

JOHN EVANS, D.C.L., LL.D., F.R.S., V.P.G.S.

Reprinted from the "NATURAL HISTORY REVIEW," July, 1865

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J. S. VIRTUE AND COMPANY, LIMITED, 26, IVY LANE

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PREFACE.

AT a time when owing to the discovery of a second specimen of the *Archæopteryx* in the Solenhofen beds, of the same general character as that preserved in the British Museum, this interesting example of an extinct form of life is again attracting so much attention from palæontologists, it has appeared worth while to reprint a short article relating to certain details in its bony skeleton. These remarks appeared some sixteen years ago in that useful, but now also extinct periodical, *The Natural History Review*,* and related to observations made in 1862 on portions of a cranium and a jaw in the slab containing the remains of the *Archæopteryx*, described to the Royal Society by Professor Owen.† With them was printed a letter from the veteran palæontologist, Hermann von Meyer, which alone would be a sufficient excuse for the present republication.

With regard to the bilobed projection on the slab, which I considered to be the cast of the interior of the brain-cavity, I believe that my view is now generally accepted as correct, while the skull of the Berlin specimen‡ seems to bear out my suggestion that the eyes were of large size, and the brain placed quite at the back of the head.

* July, 1865, vol. v. p. 415.

† *Phil. Trans.*, 1863, p. 33.

‡ See *Geol. Mag.*, Decade II. vol. viii. plate xi.

That the Archæopteryx was provided with teeth in its jaws is established beyond all doubt by the Berlin fossil, while the important discoveries made of late years in America by Professor O. C. Marsh* have shown that in his Sub-Class Odontornithes there are at least two separate groups of toothed birds belonging to Cretaceous times. I may here incidentally call attention to the striking resemblance in character between the teeth of Hesperornis† and those which I regarded as belonging to the Archæopteryx on the London slab, though the latter are not so much curved towards the point. The actual curvature is, however, somewhat greater than what is shown in the woodcut at page 12.

Whether there are specific or even generic differences between the two Solenhofen birds preserved at London and Berlin respectively, is a question which may safely be left to Professor H. G. Seeley and others; I may, however, take this opportunity of calling attention to a feature in the Berlin specimen which has, I think, as yet escaped comment. It is that, along the outer margin of the right tibia, there is a series of eight or possibly nine feathers of much the same character as those along the tail, and nearly, though not quite, of the same length. They appear to lie evenly one over the other, like the feathers of the tail and wings, though at a more acute angle to the bone with which they are associated. Their orderly arrangement is more clearly discernible on the slab itself, which, by the kindness of Professor Beyrich, I have had an opportunity of examining at Berlin, than it is in the photographs. Along the inner side of the leg the feathers seem to have been of a more downy character, and they have left a more confused impression on the slab.

Professor C. Vogt‡ has spoken of the feathers on the legs as a *culotte* like that on the legs of falcons. I am, however, doubtful whether a thick mass of feathers like that which is usual on the legs of the *accipitres* would produce the same orderly impression on a slab as that presented by the fossil. The presence of these feathers on the leg is somewhat remarkable, for Professor Vogt has pointed out that the head,

* Odontornithes. Newhaven, Conn., 1880.

† Marsh, *op. cit.*, p. 15.

‡ *Revue Scientifique*, 13 Sept., 1879. *Ibid.*, 1880, p. 434.

neck, and body of the bird are entirely devoid of feathers, and even of down. It does not, however, to my mind follow that the Archæopteryx, when living, was naked in these parts ; for, while the body was lying on the shore of the Oolitic Sea, previously to its being imbedded in the fine mud of the Solenhofen beds, it seems probable that the more loosely attached feathers, such as were adapted for giving warmth as a covering rather than for affording means of flight, would become detached during the partial decomposition of the body and drift away.

The feathers of the wings and tail remain in position ; and the fact that the feathers along the leg appear to be arranged in a similar manner, and are also preserved in their proper place, may well raise a suspicion that all three sets of feathers come under the same category, and all have, in some manner, served for the purpose of flight. The imbrication of the leg-feathers one over the other, and their external position on the tibia, are also suggestive of their having thus served.

It is, I think, obvious that the form represented by the Archæopteryx occupies a place a long way down in the chain which connects reptiles and birds, and that we have yet much to learn as to the manner in which saurians, as they assumed more and more perfect plumage, began, like Dædalus, to essay a flight through the air. If the transition took place in the dinosaurs accustomed, like the *Compsognathus*,* “ to hop or walk in an erect or semi-erect position after the manner of a bird,” the fore-limbs, though free for use in experimental flying, would appear to have been somewhat short for the purpose. But where the hind and fore-limbs were almost uniform in size, it appears by no means impossible that, as is the case with the so-called flying mammals and with the Chiroptera, arms, legs, and tail all assisted in the flight.

Professor Marsh has, indeed, already suggested that the power of flight probably originated among the small arboreal forms of reptilian birds, and has instanced the flight of *Galeopithecus*, the flying squirrels (*Pteromys*), the flying lizard

* Huxley, “ Animals intermediate between Birds and Reptiles,” Royal Inst. Lecture, February 7th, 1868.

(*Draco*), and the flying tree-frog (*Rhacophorus*), as indicative of how this may have commenced. Should it eventually prove to be the case that there were what may be termed supplementary wing-feathers on the hinder extremities of such early forms of birds as the Archæopteryx, his views as to the origin of the powers of flight will be satisfactorily confirmed. The interest attaching to such speculations must be my excuse for having extended this preface to a length so disproportioned to the matter which follows.

J. E.

NASH MILLS, HEMEL HEMPSTED,
8th November, 1881.

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ON PORTIONS OF A CRANIUM AND OF A JAW, IN THE SLAB
CONTAINING THE FOSSIL REMAINS OF THE ARCHÆOPTERYX.
By John Evans, F.R.S., F.G.S.

It will be remembered that in the admirable and exhaustive account of the slab containing the unique remains of the *Archæopteryx lithographica* of Von Meyer (*A. macrura*, Owen) read before the Royal Society in November, 1862, by Professor Owen, it was stated that beside some other less important portions of the skeleton, the head of that marvellous bird was wanting on the stone; and it was suggested that as the front margin of the slab had been broken away short of the anterior border of the impression of the outspread left wing, the head or skull of the specimen might have been included in that part of the quarry or stone from which the slab had been detached.

But upon a careful examination of the slab made on two separate occasions soon after the reading of that paper, I discovered two objects which appeared to have escaped Professor Owen's notice, one of which I thought might with safety be referred to the head of the Archæopteryx, and the other, though of much more doubtful attribution, might possibly belong to it also.

I at once brought this discovery under the notice of Professor Owen, and on the publication of his paper in the *Philo-*

sophical Transactions for 1863, he called attention to the subject by engraving the objects in the margin of the plate of the slab containing the *Archæopteryx* remains, and also appended the following succinct remarks in his explanation of the plate.

n. Concretionary nodules: the larger one consists of matrix, which filled a cavity, *n'*, formed by a thin layer of brownish and crystalline matter; which may be, as suggested by Mr. John Evans, F.G.S., part of the cranium with the cast of the brain of the *Archeopteryx*.

n' Cavity with a layer of brown matter, in the counterpart of slab, which was applied to the nodule *n'*.

Fig. 3 *p'*. Premaxillary bone, and Fig. 1 *p*, its impression, resembling that of a fossil fish.

Professor Owen has also engraved for comparison, a cast of the fore-part of the brain-cavity of a magpie which I left with him, but has abstained from offering any decided opinion as to the correctness of my attribution of the corresponding object on the slab to the head of the *Archæopteryx*.

As some time has now elapsed, and I have seen no reason to make any change in my views, I venture to bring the subject again before the public.

The fossil bird, as is well known, is preserved on two slabs of the Solenhofen lithographic stone. One of these, containing the principal bones and the clearest impressions of the feathers, I shall speak of as the principal slab; and the other, which though containing but few of the bones, is still of the utmost importance for completing our knowledge of the character of the fossil, I shall term the counterpart.

On the principal slab, between the posterior margin of the right wings and the lower extremity of the right *tibia* of the bird, is a rounded protuberance, in general outline forming a crescent, with a depression in the centre of its convex side, dividing it into two lobes. On the concave side of the crescent, the limestone of the slab rises to a higher level than it does on the convex side, so that the outline of the lobes is not so well defined on that side, and the upper portion of one of them has moreover been broken off together with a portion of the matrix. Around the margin of the crescent-shaped

protuberance may be discerned a section of a thin film of sparry matter, representing the place where bone has been, which is continued on in a curved line beyond the outer end of the more perfect lobe, forming as it were a long thin horn of the crescent.

The counterpart does not exactly correspond with the principal slab, as a portion of the matrix has been chipped away from the latter since the block was split, causing the injury to one of the lobes which I have already mentioned ; but in it is a crescent-shaped portion of the sparry layer which takes the place of bone in the slab, showing the two concavities in which the rounded lobes on the principal slab were moulded, with a projecting ridge between them.

There can, I think, be but little hesitation in recognising in this crescent-shaped object, a portion of the anterior part of the missing cranium of the Archæopteryx, while on the slab itself is a cast of a portion of the brain-cavity, showing distinctly the two hemispheres of the brain and the median line, corresponding with the intercerebral ridge, which is so plainly visible on the counterpart.

Indeed, so evidently is this the case, that Mr. Carter Blake recognises upon the cast of the brain "the site of the olfactory lobes,"* and perhaps "some trace of the optic lobe beneath the brain."

To those who have carefully examined the fossil, it may seem superfluous to attempt to prove that these remains are really organic ; but as I understand that some doubts have been expressed upon this point, I would call attention to the following facts :—

1st. That the presence of a layer of calcareous spar of exactly the same character as that which distinguishes the bones upon the slab is evident around the bilobed projection on the principal slab, and the mould in the counterpart in which they were formed is a continuation of the same sparry layer.

2ndly. That assuming this sparry layer to represent the former existence of bone, as to my mind it undoubtedly does, there is no bone which presents an analogous bilobed cavity with the exception of the skull ; and

* Geologist, vol. vi. p. 7.

3rdly. That the position of the remains refers them to the Archæopteryx, while the ornithic character of the cast of the brain-cavity is in perfect accordance with the other portions of the skeleton of this curious creature.

I therefore regard the evidence on which rests the attribution of this part of the fossil to the head of the Archæopteryx as sufficiently conclusive to justify some further speculation upon the subject. I would, however, rather leave this to others better versed in anatomy, and will only venture upon a single suggestion with regard to the position of the brain in relation to the beak.

Although from the nature of the matrix in which the skull was embedded, there has probably been some compression and distortion of its form, yet these appear to have been but slight and not sufficient to affect in any material degree the shape of the interior cavity, of a portion of which we have here a cast in indurated mud. For the sake of comparison I have made plaster casts of the brain-cavities of a number of birds belonging to different orders; and though I find a considerable range in the proportion of the brain-cavity to the other parts of the skull, and also in the character and extent of the intercerebral ridge, yet the general resemblance of the anterior portion of the brain of all the birds which I have examined to that of the Archæopteryx is most distinct. The casts of the interior of the fore-part of the skulls of the Jay and the Woodcock (*Garrulus glandarius* and *Scolopax rusticola*) more particularly exemplify this resemblance. We may from this and from the presence of feathers (as was so well pointed out by Professor Owen), infer that the Archæopteryx was provided with a beak more or less analogous in character with that of other birds.

There is, however, great variation in the position of the brain with regard to the beak in different families of birds; the base of the brain being in some cases nearly at right angles to the opening of the bill, and in others inclined at but a slight angle to it. This more or less vertical position of the brain appears to be dependent on the greater or less development of the orbits of the eyes. In the Woodcock, for instance, where the eyes are very large in proportion to the brain, the base of the latter is nearly vertical to the opening

of the beak, and when the skull of such a bird, even with both mandibles removed, rests with its under side upon a horizontal surface, the position of the base of the brain is nearly vertical. From the position of the skull of the Archæopteryx upon the slab it would appear to have been detached from the neck before being finally embedded in the mud from which the Solenhofen limestone was formed. There is, as will subsequently be seen, some reason also for supposing that the mandibles had become detached; but at all events the skull appears to have lain upon the shore, with the base downwards, as probably presenting the best surface on which to rest, and with the frontal region upwards. But the base of the cast of the brain appears to be nearly vertical to the slab, which is split so as to display the old shore surface. It seems, therefore, probable that the base of the brain may in the Archæopteryx have formed nearly a right angle with the opening of its beak, and if so, that, as is the case with most other birds with the same peculiarity, its eyes were of large size, and the brain placed quite at the back of the head. But enough has been said of a hypothesis built upon such slender foundations, and I will therefore now describe another object upon the same slab, some of the details of which appear to have escaped the attention of previous observers.

On the principal slab in the angle between the right femur and tibia is a small V-shaped object, the longer of the two limbs about $1\frac{1}{2}$ inches in length, made up partly of mineralised bone and partly of impressions of other portions of the same bones preserved in the counterpart slab. From its form it had, I believe, been considered as possibly representing the beak of the Archæopteryx; but great was my surprise when I detected along its right-hand margin, towards the apex, the distinct impression in the slab of four teeth still attached to it. The teeth themselves remain engaged in the counterpart, and are easily recognised by the lustre of their enamel. There seems also to be a portion of a fifth tooth visible, which has been displaced and lies across the base of that nearest the point of the jaw. The portion of the jaw to which they are attached is unfortunately much injured, and there is no appearance of any teeth in connection with the

other limb of the V.* The woodcut below gives both views of the object.

Whether the whole is a lower jaw, with the teeth, or rather a few of them, remaining in one half only, and with the symphysis of the jaw at the point of the V ; or whether it is a portion of an upper jaw in which the second limb of the V would be probably part of the facial and nasal bones, I cannot pretend to determine ; and I am afraid that the whole is in too fragmentary and obscure a condition for any positive conclusions to be drawn on this point.

The character of the teeth, however, appears to me to be well defined. The three which remain in a vertical position with regard to the jaw are about $\cdot 10$ inch long, and at intervals of about $\cdot 20$ inch. They consist of a slightly tapering



Jaw as seen on Principal Slab.



Jaw as seen on Counterpart.

flattened enamelled crown, about $\cdot 04$ inch in width and obtusely pointed, set upon what is apparently a more bony base which widens out suddenly into a semi-elliptical form, so that at the line of attachment to the jaw, the base of one tooth comes in contact with that of the next. So sudden and extensive is this widening of the base, that at first it gave me the impression that the teeth were tricuspidate, with the middle cusp far longer than the others.

The front tooth of the four, which slopes forward from the rest, and is rather smaller than the others, shows little if any similar enlargement of its base. Of the fifth, which lies across the base of the foremost of the other four, only a part is visible. There appears to be a well-defined line at the base of the teeth along their junction to the jaw ; but I can

* For the use of this cut I am indebted to Mr. Norgate.

offer no opinion as to the method of their attachment. It is of course contrary to all our existing notions to suppose that a jaw such as this, armed with teeth, could belong to a creature so truly bird-like in most respects as the Archæopteryx ; but assuming it to be that of a fish—and it has many analogies with the jaws of some species of fish—or of some other animal accidentally deposited in the very midst of the remains of that singular creature, it appears to me that, fragmentary as it is, its characters are sufficiently defined for any one well versed in the fossils of the Solenhofen slate to come forward and identify it.

Up to the present time, however, I have not heard of any one having been able to do so, and certainly the jaws and teeth of the Lepidotous and Pholidophorous fishes from the same beds, such as I have been able to examine, all differ from this in some more or less important particulars. It appears to me also, that the teeth and jaw on the Archæopteryx slab are rather slighter in structure than those of fishes of corresponding size, though this is a point on which I would by no means insist.

Looking at the usual dispersion of the fossils in the Solenhofen slates, looking also at the general rule (to which, however, there are some exceptions) that the fossils in it are found singly, so that all the remains of a reptile or a fish upon a single slab may usually be assigned with some degree of confidence to a single individual, the chances against a single extraneous jaw being mixed up with the remains of the Archæopteryx, without any other bones of the animal to which the jaw belonged being also present, are great indeed. But how enormously are the chances against such an occurrence increased if the jaw thus accidentally present is that of a species of fish or reptile hitherto unknown !

In order to obtain information from the best possible source, as to whether the jaw and teeth were of a character well known to those acquainted with the Solenhofen fossils, I prepared a careful drawing of it and placed it in the hands of my lamented friend, the late Dr. Falconer, who kindly wrote to the illustrious Hermann von Meyer upon the subject.

The following is a translated extract from his answer (dated

from Frankfort the 4th April, 1863) which Dr. Falconer kindly placed in my hands :—

“In Palæontology it is difficult to judge from drawings, but
 “the two supplementary objects which Mr. John Evans has
 “succeeded in discovering upon the Archæopteryx slab are
 “certainly of the greatest importance. Upon the part which
 “may belong to the hinder-part * of the skull I hazard no
 “opinion.” “Much more important is the jaw. Teeth of
 “this sort I do not know in the lithographic stone. There
 “exists no similarity between them and the teeth of Ptero-
 “dactyles. The nearest likeness is to the teeth of my
 “family of *Acrosaurus*, namely, to the *Acrosaurus Frisch-*
 “*manni*, Meyer (Reptilien des. lithog. Schiefers, p. 116, t. 12,
 “f. 7-8) from the lithographic slate of Bavaria, in which,
 “however, the crown is lower and longer from back to front.
 “In *Pleurosauros Meyeri* (Pal. x. p. 37, t. 7), which belongs
 “to the same family, the teeth possess less likeness. One
 “might also be reminded of the teeth of the *Geosaurus*
 “*Soemmeringi* Meyer. (Deutsch. Akad. Munich, 1816, p. 36.
 “Cuvier, Oss. foss. Pl. 249, fig. 2—6), which, however, are
 “much longer. From this it would appear that the jaw
 “really belongs to the Archæopteryx. An arming of the jaw
 “with teeth would contradict the view of the Archæopteryx
 “being a bird or an embryonic form of bird. But after all,
 “I do not believe that God formed his creatures after the
 “systems devised by our philosophical wisdom. Of the
 “classes of birds and reptiles as we define them, the Creator
 “knows nothing, and just as little of a prototype, or of a
 “constant embryonic condition of a bird, which might be
 “recognised in the Archæopteryx. The Archæopteryx is of
 “its kind just as perfect a creature as other creatures, and if
 “we are not able to include this fossil animal in our system,
 “our short-sightedness is alone to blame.”

It will, of course, be observed that this opinion of Von Meyer is founded on my drawings alone, and is therefore of course subject to a revision on an examination of the slab itself. But there certainly appears to be a case made out for careful investigation by those more competent than I am to

* This is probably an error for “fore-part of the skull,” but no drawings of the head were sent to Herr von Meyer.

form an opinion in such a case. Its extreme importance as bearing upon the great question of the Origin of Species must be evident to all, and I for one can see no reason why a creature presenting so many anomalies as the Archæopteryx, all of which, however, tend to link together the two great classes of Birds and Reptiles, should not also have been endowed with teeth, either in lieu of, or combined with a beak, in the same manner as in the *Rhamphorhynchus*, with which it exhibits other affinities. The tooth-like serrations in the beaks of many birds—and notably in the Merganser Serrator, where they closely approach in character to real teeth, though connected only with the horny covering and not with the bones of the mandible—are sufficient to prove that the presence of feathers does not of necessity imply that the beak with which to preen them should be edentulous.

